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PERMIAN ELEMENTS IN THE FOSSIL FLORA OF THE APPALACHIAN PROVINCE. II. WALCHIA

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Walchia is a synthetic genus of Paleozoic conifers. The foliage-shoots attributed to this genus are characterized by a pinnate arrangement of the ultimate branches. The small, tetragonal, crowded leaves are spirally disposed—laxly or densely. A few species have been described from shoots bearing terminal cones, but the majority are poorly defined vegetative types. *Walchia* is abundant in Permian floras and occurs less abundantly in the Upper Carboniferous (or Stephanian). It is one of the ubiquitous late Paleozoic genera.

The genus includes ten or twelve "species", following the conventional concept of Sternberg.[1] In the past decade Professor Florin[2] of Stockholm began a monographic revision of the Paleozoic conifers, and the whole group will be placed upon a satisfactory basis. Florin's results have not yet appeared in full, although he has already instituted several important new genera based upon reproductive shoots.

[1]Vers. Fl. Vorwelt. vol. 1. p. 22
[2]Proc. Int. Congr. Pl. Sci. (1926) Ithaca. pp. 401-411

The most important and widespread of the Paleozoic conifers is *Walchia piniformis* (Schlotheim) Sternberg.[3] It occurs in both Permian and Stephanian rocks of the northern hemisphere. In the vegetative condition this species is distinguished with difficulty from *Walchia hypnoides* Brongniart and *Walchia filiciformis* (Schlotheim) Sternberg. Florin[4] has created a new genus *Ernestia* for the latter species.

The present note is concerned with the occurrence of three specimens of *Walchia* from eastern North America. One is from the Stephanian ("Permian") of Prince Edward Island, and the other two from western Pennsylvania. Of these one is Stephanian and the second Permian. The three specimens fall within the range of variability of *Walchia piniformis*, although the piece from Prince Edward Island conforms also to *Walchia gracilis* Dawson. The material contains only vegetative branches, and in the absence of reproductive shoots, an assignment to these unsatisfactory species is the most convenient. A score of cellulose transfers have failed to reveal diagnostic cellular structures.

WALCHIA Sternberg 1826 Vers. Fl. Vorwelt; vol. 1. p. 22.

Walchia piniformis (*Schlotheim*) *Sternberg*

1820 *Lycopodiolithes piniformis* Schlotheim
Petrefactenkunde p. 415. pl. 23. figs. 1, 2. pl. 25. fig. 1.

1826 *Walchia piniformis* Sternberg
Vers. Fl. Vorw. vol. 1. p. 22.

1828 *Lycopodites piniformis* Brongniart
Prodrome p. 89.

1870 *Walchia piniformis* Schimper

[3] Petrefactenkunde p. 415

[4] Arkiv Bot. Bd. 21A. No. 13. 1927

Traite Pal. Veg. vol. 2. p. 236. pl. 73. figs. 1, 2?

1885 *Walchia piniformis* Renault

Cours bot. foss. vol. 4. p. 84. pl. 8. figs. 1-3.

1892 *Walchia piniformis* Zeiller

Bass. houill. Perm. Brives p. 97. pl. 15. fig. 1.

1893 *Walchia piniformis* Potonie

Fl. Rotl. Thuringen p. 218. pl. 31. figs. 4, 6.

1906 *Walchia piniformis* Zeiller

Bass. houill. Perm. Blanzy et Creusot p. 204. pl. 50. figs. 3, 5.

1908 *Walchia piniformis* Sellards

Univ. Kans. Geol. Surv. vol. 9. p. 460. pl. 66. figs. 1, 2.

1929 *Walchia piniformis* White

Fl. Hermit Shale p. 96. pl. 41. figs. 1-5. pl. 42. figs. 1-5. pl. 47. fig. 2.

There are many excellent published figures of this species. I have selected several to indicate the variety of coniferous shoots which have been included within a single "species". With the exceptions of the first three monographs, the references are generally available in large libraries.

The two specimens from western Pennsylvania are, for the present, best referred to this poorly defined species, which as White[5] says "is an aggregate of similar forms rather than a single species." One specimen is from the Clarksburg member of the Upper Conemaugh at Rennerdale, Allegheny County, Pennsylvania. The other is from the Nineveh coal group in the Greene at Mount Morris, Greene County, Pennsylvania.[6]

The specimens may be described as follows: twigs short; clothed with persistent, incurved, spirally dis-

[5]Flora Hermit Shale p. 97

[6]Penna. Top. & Geol. Surv. Bull. C-30. p. 100. 1932

posed, short, needle-like leaves, decurrent at the base; twigs depart at an angle 60°-70°, straight, tapering slightly. The leaves are fewer and more distantly placed on the Greene Specimen.

The third specimen discussed in this note is from Miminigash, Prince Edward Island. It was presented to Harvard University in 1875 by Francis Bain. Bain had identified the specimen as *Araucarites gracilis* Dawson. The specimen in our possession is from the type locality of Dawson's plant, which David White renamed *Walchia dawsoni* sp. nov.

Walchia dawsoni *White* 1929

Fl. Hermit Shale p. 99. pl. 44. figs. 1, 4, 4a. pl. 42. fig. 6? pl. 43?

1871 *Walchia (Araucarites) gracilis* Dawson
Rept. Geol. Struct. & Min. Res. P. E. I. p. 43. pl. 2. fig. 23A, nec Emmons, nec Oldham and Morris, nec Walkom.

DIAGNOSIS: (White loc. cit. p. 99.)

"Branches apparently flat, distichous, with close and slender ultimate twigs, hardly tapering until near the blunt apex; leaves close, decurrent, linear-lanceolate, dorsally carinate, curving outward, and in the upper part curving upward and inward uncinnately or more or less distinctly falcately at the rather narrowly acute apex, 3 to 6 mm. long, and broadest at the base, which is slightly carinate dorsad."

The specimen before me agrees with the figures published by Dawson from Nova Scotia and Prince Edward Island. White regarded the Nova Scotian plant as a distinct species. On this slab are branches of the diminutive size suggested by Dawson's figures and larger branches as large as those of the "typical" *Walchia piniformis*. White called attention to the close relationship between

Walchia dawsoni and *Walchia hypnoides* from Lodeve, France. Kidston remarked, "probably this species is only a smaller form of *Walchia piniformis.*"

I have compared the Prince Edward Island plant with eight specimens from Lodeve, France (five attributed to *W. hypnoides* and three to *W. piniformis*) identified by Bronn, Heer, Lesquereux, and de Koninck.

The American species is distinct "on account of the very steadily tapering and blunt appressed leaves of the plant from Lodeve, whereas the leaf of the tree from the Permian of Canada, as shown in detail by Dawson, is much more slender, tapering mainly toward the tip, which is, however, slender, acute, and more strongly upturned near the apex." (White loc. cit.).

These characters are constant in the material at my disposal, consequently I concur with the opinion of David White that is is improbable that *Walchia dawsoni* will be proven to be identical with *Walchia hypnoides.* However, Dawson's several specimens identified as *Walchia gracilis* do represent a single species, which must be known as *Walchia dawsoni* White. Recently Henry Donner has sent me a specimen of *Walchia* from the supposed Permian of Colorado. The fragment is insufficient for certain identification. It agrees well with *Walchia dawsoni* except that the needles are more robust and more distant. I doubt if this is a specific difference.

In North America, *Walchia* is abundant in the Lower Permian. Lesquereux identified several species from Fairplay, Colorado.[7] I.C. White[8] reported the genus from the Wichita (=Permian) of Texas, and David White[9] reported many specimens from Texas, Kansas, Oklaho-

[7]Acad. Geol. (4th. ed.) p. 474. fig. 159 A. 1891
[8]Bull. Geol. Soc. Am. vol. 3. pp. 217-218
[9]Proc. U. S. Nat. Mus. vol. 41. pp. 505-508

ma, Colorado, New Mexico, and Arizona. The Permian occurrences in southwestern United States are indicated by the following:

Walchia piniformis	Texas, Colorado, Arizona, Kansas
Walchia schneideri	Texas
Walchia imbricata	Oklahoma, Arizona
Walchia hypnoides	Colorado
Walchia aff. gracilis	Oklahoma, Colorado
Walchia aff. filiciformis	Kansas
Walchia sp.	Kansas

Several of Lesquereux's specimens from Colorado have been transmitted to Doctor Florin for study.

David White has also recorded *Walchia* from the Permian Hermit Flora of Arizona. He referred the material to four species: *Walchia dawsoni*, *W. gracillima*, *W. piniformis*, and *W. hypnoides*.

I. C. White noted that in the Wichita of Texas, *Walchia sp.* is found in association with a fern flora of Dunkard species.

The eastern American records are of significance because no occurrences of *Walchia* have hitherto been known except in Nova Scotia and Prince Edward Island.

Walchia makes its appearance in western Pennsylvania in rocks of Conemaugh age in the zone of *Lescuropteris*.[10] These rocks are of Stephanian age, as is evidenced by the plants associated in the same strata.

Pecopteris hemitelioides	Neurpoteris aff. ovata
Pecopteris arborescens	Neuropteris neuropteroides
Pecopteris polymorpha	Neuropteris scheuchzeri
Pecopteris feminaeformis	Odontopteris reichi

[10]Darrah, Summaries of Papers Carb. Congr. pp. 1-8. 1935

Pecopteris cistii
Pecopteris daubreei
Pecopteris lamurensis
Sphenopteris minutisecta
Dicksonites pluckeneti
Alethopteris magna
Alethopteris grandini
Lescuropteris moorii
Zygopteris erosa
Odontopteris genuina
Odontopteris sp. nov.
Calamites suckowi
Annularia sphenophylloides
Annularia stellata
Sphenophyllum oblongifolium
Cordaianthus sp.
Walchia aff. piniformis

Although this same general Upper Carboniferous flora continues to populate western Pennsylvania during Monongahela and Washington time, *Walchia* has not been found in either series of rocks. It has been found in the Greene series, at Mount Morris, in the following association:

Callipteris conferta
Sphenopteris sp.
Neuropteris odontopteroides
Odontopteris pachyderma
Pecopteris arborescens
Walchia aff. piniformis

Two additional forms occur in olive shales twelve feet above:

Pecopteris polymorpha
Odontopteris cf. reichi

The Greene rocks are of lower Permian age. *Callipteris conferta*, in a small variety, is very common.

It is evident that in western Pennsylvania, *Walchia* occurs in the Upper Carboniferous as well as in the Permian. The same range has been cited for *Walchia* in Kansas,[11] and for the Cisco (=Monongahela) of Texas.

The occurrence of conifers in Prince Edward Island and Nova Scotia involves again, the relative geological age of the strata in which *Walchia* has been found. Dawson considered them to be of Permian age, and most in-

[11]Elias, XI Int. Geol. Congr. Abstracts. pp. 69, 70. 1933

vestigators have concurred in this opinion.

The specimen from Prince Edward Island, which was sent in a small lot by Bain in 1875 includes: *Callipteridium aff. pteridium*, *Pecopteris arborescens*, *Alethopteris grandini*, and *Sphenophyllum oblongifolium.*[12] Small fragments of *Walchia* are abundant. The matrix of the rock is a red micaceous sandstone of fine grain. This assemblage presents no Permian indicators but rather resembles the typical Monongahela (= Stephanian) flora of Pennsylvania.

Walchia is known to occur in the Upper Carboniferous of England,[13] Wales,[14] France,[15] and elsewhere,[16] although it is characteristic of the Lower Permian. No reliance is placed upon its presence as an indication of Permian age. However, it is a precursor of the typical Permian flora to come. In this sense its appearance is an important factor in determining the process of plant sequence in the late Paleozoic.

Walchia had been sought in Pennsylvania for fifty years without reward, but its rarity is of less importance than its presence. David White[17] believed that some physiographic or climatic barrier prevented the migration of conifers into the area of Dunkard deposition.

It is true that during the Conemaugh, orogenic movements associated with the Appalachian revolution caused many lasting changes in regions to the west in Pennsylvania. It is also true that the rapid plant evolution and floral changes in western Pennsylvania, were contemporaneous with these earth changes.

[12]Darrah, loc. cit. p. 4
[13]Crookall, Coal Meas. plants. 1929
[14]Dix, Trans. Roy. Soc. Edinb. vol. 57. p. 815. 1934
[15]Bertrand, C. R. Congr. Strat. Carb. p. 109. 1928
[16]Gothan, Carb. u. Perm. Pflanzen
[17]Personal Communication dated June 26, 1933

The beginnings of the Permian flora in Pennsylvania extend far down into the Carboniferous. Certain Permian precursors are almost coextensive with the Stephanian. The earliest appearances of Stephanian pecopterids occur in Middle Allegheny following the deposition of the Vanport marine limestone. Numerous lower Allegheny and even Pottsville plants persist, but here is the key to the whole problem. The next marine incursion eliminates the Pottsville-Allegheny complex and results in a new flow of migrants from the north-east (presumably Europe).

There are five distinct marine invasions in the Upper Pennsylvanian rocks of western Pennsylvania. Each marine invasion resulted in a local extermination of the terrestrial fauna and flora. Repopulation of the region subsequently was effected by migrants from districts nearby, where the topography had not been so seriously altered.

During the interval between the Vanport limestone (Middle Allegheny) and the Brush Creek limestone (Lower Conemaugh), the flora is essentially the *Neuropteris ovata* facies in association with Stephanian pecopterids and mariopterids of the *Mariopteris nervosa* group.

Three marine limestones occur in the middle third of the Conemaugh Series: Pine Creek, Woods Run, and Ames. The most extensive of these is the Ames limestone—a persistent bed with the following faunule: *Enteletes hemiplicatus var.*, *Spirifer cameratus*, *Ambocoelia planoconvexa*, *Chonetes granulifer*, *Productus cora*, *Lophophyllum profundum*, and a fusiline. Professor C. O. Dunbar has identified the fusiline as *Triticites collumensis* Dunbar and Condra. Among the rarer forms in this faunule, are species of *Pseudomonotis* and *Edmondia*.

With the invasion by the Ames Sea, there is a marked floral change—a change which permanently al-

tered the flora of Appalachia. The first plants to repopulate western Pennsylvania were relict survivors of the Allegheny flora: *Neuropteris ovata*, *Neuropteris scheuchzeri* and *Pecopteris lamurensis*. Of these only *Neuropteris scheuchzeri* regained a lasting place in the higher floras. *Neuropteris* (*Mixoneura*) *ovata* was gradually replaced by *Neuropteris* (*Mixoneura*) *grangeri* and *Neuropteris* (*Mixoneura*) *neuropteroides*. *Pecopteris lamurensis* was quickly eliminated. At the same time there was a steady influx of rejuvenating younger types, which were the typical Upper Stephanian and Permian plants from western Europe.

In the Upper Conemaugh *Walchia*, *Odontopteris*, *Lescuropteris*, and *Callipteridium* make their first appearances. Soon after *Taeniopteris* and *Baiera* migrated into the region of Dunkard sedimentation. The progressive change culminates in the arrival of *Callipteris*.

No marine conditions occurred in western Pennsylvania above the Ames Limestone, with the exception of two local, insignificant recurrences in the Upper Conemaugh. The reported marine limestone in the Dunkard of Ohio[18] is an unfortunate error.

It is observed then, in the type section of the Upper Pennsylvanian, how *Walchia* occurs in the normal, undisturbed, stratigraphic sequence. This coniferous genus is but one of many genera which appear in chronologic succession, precisely as in the standard floral successions of the Carboniferous and Permian in western Europe.

The occurrence of *Walchia* in the typical "coal flora" of fern-like foliage is of more than casual interest. The rarity and fragmentary nature of the two specimens from Pennsylvania indicates that they drifted into the sediments in which they became preserved. *Walchia* prob-

[18]Ohio Geol. Surv. (4th. Ser.) Bull. 22. 1920

ably grew at a higher elevation than the typical "coal-swamp" of near tide-level. This ecological difference may account for the scarcity of records in eastern North America. Nevertheless the extensive geographic distribution and relative abundance of *Walchia*, renders it one of the most useful Paleozoic plants in determining correlations and chronologies.

Two recent discoveries of *Walchia* in western American deposits indicate that the early appearance of such conifers is quite general. In Kansas *Walchia*, in a so-called Permian flora, is abundant in Conemaugh equivalents. There is no evidence of the presence of *Callipteris*, although Jongmans believed it to be common. The basis for his opinion was *Dichophyllum moorei* Elias. The Pennsylvanian age of these plants in Kansas is thoroughly demonstrated. The second occurrence of *Walchia* in supposed pre-Premian rocks is a single specimen from the vicinity of Fairplay, Colorado collected by Henry Donner. There are several determinable fragments in association, but probably not sufficient for purposes of correlation. A small fragment, which I believe is referable to *Callipteris naumanni* would seem to suggest a Permian age, but the general consensus of opinion based on invertebrate faunas in the region is that the rocks are Pennsylvanian.

Precise determinations must be based on adequate material and precise correlations are possible only by means of a reasonably large number of specimens. *Walchia* in itself cannot give us the relative age of a late Paleozoic florule. *Walchia* in company with *Taeniopteris* indicates a zone in the immediate boundary between Permian and Pennsylvanian. With this common and widespread association—at least Stephanian in age—it is possible to determine the early appearances of *Lescuropteris*, *Callipteris*, and *Sphenozamites*.